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FORTY-EIGHTH ANNUAL REPORT
OF THE
NORTH CAROLINA
AGRICULTURAL EXPERIMENT
STATION

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27 OCT. 1927

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THE NORTH CAROLINA STATE COLLEGE OF
AGRICULTURE AND ENGINEERING

State College Station

Raleigh

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THE NORTH CAROLINA STATE COLLEGE OF
AGRICULTURE AND ENGINEERING

State College Station

Raleigh



FOR THE
FISCAL YEAR ENDED JUNE 30, 1925
STATISTICAL SUMMARY FOR YEAR ENDING DECEMBER 1, 1925

LETTERS OF SUBMITTAL

RALEIGH, N. C., February 11, 1926.

HON. A. W. McLEAN,
Raleigh, N. C.

MY DEAR GOVERNOR:

I take pleasure in transmitting to you the annual report of Dr. R. Y. Winters, the Director of the Agricultural Experiment Station of the North Carolina State College of Agriculture and Engineering, for the year ending June 30, 1925.

This report will give you a very good idea of the scope of the agricultural research conducted in North Carolina, its importance to the farmers of our State and its relation to agricultural progress.

Very sincerely yours,

E. C. BROOKS, *President.*

RALEIGH, N. C., January 27, 1926.

PRESIDENT E. C. BROOKS,
State College Station,
Raleigh, N. C.

DEAR MR. BROOKS:

I have the honor to submit herewith the annual report of progress in agricultural research of the Agricultural Experiment Station of the North Carolina State College of Agriculture and Engineering. This report includes the results accomplished during the fiscal year ending June 30, 1925.

This report is made in accordance with requirements of the Act of Congress approved March 2, 1887, and known as the Hatch Act, and Chapter 68 of the Public Laws of 1913, and amended by Chapter 223 of the Public Laws of 1917.

Very respectfully,

R. Y. WINTERS, *Director of Research.*

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STAFF OF THE NORTH CAROLINA EXPERIMENT STATION

ADMINISTRATION

R. Y. WINTERS.....	Director, Experiment Station
C. B. WILLIAMS.....	Vice-Director, Experiment Station
†F. E. MILLER.....	Assistant Director, Branch Stations
F. H. JETER.....	Agricultural Editor
A. F. BOWEN.....	Treasurer

AGRONOMY

R. Y. WINTERS	Assistant in Soils
In Charge of Plant Breeding Investigations	
P. H. KIME.....	Soil Chemist
Assistant in Plant Breeding	
G. M. GARREN.....	Soil Survey
Assistant in Plant Breeding	
W. F. PATE	Soil Survey
In Charge of Soil Fertility Investigations	
S. K. JACKSON.....	Soil Survey
Assistant in Soils	
H. B. MANN.....	Soil Survey
L. G. WILLIS.....	Soil Survey
F. R. BACON.....	Soil Survey
W. A. DAVIS.....	Soil Survey
*R. C. JUNEY.....	Soil Survey
*W. B. LEE.....	Soil Survey

ENTOMOLOGY

†FRANKLIN SHERMAN	Assistant Investigations and Field Work
Chief, Division of Entomology	
Z. P. METCALF.....	Assistant Investigations
Entomologist	
†R. W. LEIBY	Assistant Investigations
Assistant Entomologist Investigations	
†C. S. BRIMLEY.....	Assistant Investigations
Assistant Investigations	
†T. B. MITCHELL	
Assistant Investigations and Field Work	
†J. C. CRAWFORD.....	Assistant Investigations
Assistant Investigations	
†J. A. HARRIS.....	Assistant Investigations

HORTICULTURE

C. D. MATTHEWS	Assistant Horticulturist, Pomology
Chief, Division of Horticulture	
†ROBERT SCHMIDT.....	Assistant Horticulturist, Research
Vegetable Culture	
†W. A. RADSPINNER	
Assistant Horticulturist, Pomology	
C. F. WILLIAMS	
Assistant Horticulturist, Research	

ANIMAL INDUSTRY

R. S. CURTIS.....	Chief, Animal Industry Division
EARL H. HOSTETLER.....	In Charge Feed and Nutrition
Swine Investigations	
L. H. MCKAY.....	Assistant in Nutrition
Assistant Swine Investigations	
VERNON WILLIAMS.....	Assistant in Nutrition
Dairy Investigations	
†J. O. HALVERSON	
In Charge Feed and Nutrition	
†F. W. SHERWOOD.....	Assistant in Nutrition
Assistant in Nutrition	
†H. A. DICKERT.....	Assistant in Nutrition

POULTRY

B. F. KAUPP.....	Chairman, Poultry Group
R. S. DEARSTYNE.....	Associate in Poultry Diseases

PLANT PATHOLOGY

F. A. WOLF.....	Plant Pathologist
S. G. LEHMAN.....	Assistant Plant Pathologist

DRAINAGE

†F. O. BARTEL.....	Drainage Engineer
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† BRANCH STATIONS

R. E. CURRIN, JR.....	Assistant Director, Upper Coastal Plain Branch Station
L. O. PAGE.....	Swine Herdsman
F. T. MEACHAM.....	Assistant Director, Piedmont Branch Station
S. C. CLAPP.....	Assistant Director, Mountain Branch Station
H. B. COULTER.....	Dairy Herdsman
P. H. DUNCAN.....	Poultryman
W. M. WHISENHUNT.....	Foreman
CHARLES DEARING.....	Assistant Director, Coastal Plain Branch Station
T. H. CAMERON.....	Dairy Herdsman
C. D. BOLLINGER.....	Poultryman
D. P. SOUTHERLAND.....	Foreman
E. G. MOSS.....	Assistant Director, Tobacco Branch Station
THOMAS ALLEN.....	Foreman
J. L. REA, JR.....	Assistant Director, Blackland Branch Station
A. P. LEFEVRES.....	Swine Herdsman

* In co-operation with United States Department of Agriculture.

† Under authority of the North Carolina State Department of Agriculture, co-operating with the North Carolina Experiment Station in Research.

FORTY-EIGHTH ANNUAL REPORT
OF THE
NORTH CAROLINA AGRICULTURAL
EXPERIMENT STATION

FOR THE
FISCAL YEAR ENDING JUNE 30, 1925

By R. Y. WINTERS, *Director*

The history of the Agricultural Experiment Station for the past year will be recorded as one of re-organization and co-ordination. The re-organization has had for its purpose the centralization of all agricultural research in the College of Agriculture, and the formulation of a more definite agricultural program. The co-ordination has had for its purpose the linking together of the three phases of agricultural work—research, teaching and extension—in such a way as to make them of mutual benefit and of greatest value to the agriculture of North Carolina.

MEMORANDUM CONCERNING RESEARCH

The following memorandum of understanding between President E. C. Brooks, of the State College of Agriculture and Engineering, and Commissioner W. A. Graham, of the State Department of Agriculture, outlines the present organization of agricultural research in the State:

“The agreement between the North Carolina State College of Agriculture and Engineering and the State Department of Agriculture concerning research work is as follows:

“1. All research work in the State is conducted either by the College or by the Department of Agriculture under the supervision of the Director of the Experiment Station of the College. This agreement has been consistently followed. But arrangements have been completed for the College to take over the remainder of the research work in Feed Nutrition and in Entomology at the close of the present scholastic year. This will take from the Department of Agriculture the balance of the research conducted by members of that department. Therefore, at the end of the year 1925-26 the College will have full control of all the research work conducted in the State.

"2. The test farms owned and supported by the Department of Agriculture are used by the College for conducting experiments or research in such manner and to such an extent as the President of the College and the Commissioner of Agriculture may determine; and the Director of Research of the College is given full authority to plan and supervise any research work on the test farms without referring the same to the President or to the Commissioner, provided the total expense of conducting the same in one year does not exceed the total expense of the preceding year.

"3. The Department of Agriculture maintains a Supervisor of the test farms and the Department agrees to keep its force and provide service for the use of the College. The test farms, therefore, are under the supervision of the Director of the Experiment Station and the Supervisor of the test farms. They, working jointly, can carry out any program that may be mutually agreed upon.

"But in a case of disagreement, the matter may be settled by the President of the College and the Commissioner of Agriculture, and if they are unable to agree, the matter may be referred by either to a joint committee composed of the Governor and equal representatives from the Board of Agriculture and the Board of Trustees of the College."

RESEARCH AND TEACHING

The assignment of special lectures or courses to members of the research staff has been recognized as an effective means of extending the results of research and stimulating interest in research among advanced undergraduate and graduate students. During the past year seven members of the research staff have been assigned special courses. In all cases the subject matter of such courses is closely related to the research work of the investigator assigned. In no case has the assignment amounted to more than five hours per term, and the teaching division has borne its proportional part of the salary.

From time to time members of the teaching staff have requested time and facilities for research. During the past year provision was made for research by eleven members of the teaching staff, representing five departments in the School of Agriculture. Although this research is supported by College funds other than those of the Experiment Station, its supervision and co-ordination has been placed under the same direction as the Experiment Station research. This provision for research among teachers is certain to strengthen both the agricultural teaching and research, and should bring about a better co-operation between the research and teaching workers.

RESEARCH AND EXTENSION

From time to time members of the research staff are called upon for extension work. This usually concerns the giving of specific information along the special subject being investigated. In this work six members of the Experiment Station staff have spent from one to four weeks in the field with county agents and teachers in agricultural high schools. Members of the research staff have prepared two extension posters and six circulars presenting the results of research in a practical way for farmers.

PUBLICATIONS

The following publications of the Station were prepared, printed and distributed during the past fiscal year:

Bulletin 247. *Recent Results of Work of the Agricultural Experiment Station and Present Program of Work.*

Annual Report. *Forty-seventh Annual Report of the North Carolina Experiment Station.*

Due to lack of funds for printing, additional publications giving the results of research work were published by the State Department of Agriculture for the Experiment Station. A total of four such bulletins, comprising 17,000 copies, were issued in this way during the year. These were as follows:

August, 1924. *Culling and Feeding of Poultry.* B. F. Kaupp.

September, 1924. *Results of Fertilizer Experiments with Cotton and Irish Potatoes.* W. F. Pate and J. J. Skinner.

November, 1924. *The Mexican Bean Beetle in North Carolina and Studies for its Control.* J. C. Crawford.

February, 1925. *Insect Enemies of the Pecan in North Carolina.* R. W. Leiby.

FINANCIAL REPORT

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

In Account With the UNITED STATES APPROPRIATION, 1924-25.

Dr.

Hatch Fund Adams Fund

To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ended June 30, 1925, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund).....	\$15,000.00	\$15,000.00
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Cr.

Salaries	\$13,011.58	\$12,366.01
Labor	1,096.36	948.04
Stationery and office supplies.....	131.71	46.42
Scientific supplies, consumable.....		581.59
Feeding stuffs	68.95	
Sundry supplies	285.95	76.79
Fertilizers		193.04
Communication service	118.75	14.94
Travel expenses	253.92	276.21
Transportation of things	17.78	29.55
Heat, light, water and power.....	11.00	17.38
Furniture, furnishings, and fixtures.....	4.00	
Scientific equipment		450.03
Total.....	\$15,000.00	\$15,000.00

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

In Account With FARM AND MISCELLANEOUS RECEIPTS.

Dr.

Receipts from other sources than the United States for the year ending June 30, 1925.....	\$9,524.94
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Cr.

Labor	\$4,105.79
Stationery and office supplies.....	139.24
Scientific supplies, consumable.....	52.81
Feeding stuffs	407.07
Sundry supplies	1,072.79
Fertilizers	1,110.83
Communication service	81.90
Travel expenses	34.42
Transportation of things.....	27.31
Publications	224.45
Furniture, furnishings and fixtures.....	11.80

Library	\$ 181.29
Scientific equipment	81.25
Tools, machinery and appliances.....	533.64
Buildings and land.....	1,383.85
Contingent expenses	76.50
Total.....	<u>\$9,524.94</u>

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1925; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was nothing on the Hatch Fund and nothing on the Adams Fund; that the receipts for the year from the Treasurer of the United States were \$15,000.00 under the act of Congress of March 2, 1887, and \$15,000.00 under the act of Congress of March 16, 1906, and all the corresponding disbursements \$15,000.00 and \$15,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, leaving balances of nothing and nothing.

O. F. GODDARD, C. P. A.,
Auditor.

Attest:

A. F. BOWEN, *Treasurer,*
Custodian of the Seal.

STATE DEPARTMENT OF AGRICULTURE FUNDS USED IN SUPPORT OF AGRICULTURAL RESEARCH

1924-25

Salaries of research workers at State College	\$31,300.00
Travel and other maintenance.....	28,785.00
Salaries research workers, State Department of Agriculture.....	28,900.00
Travel and other maintenance.....	9,200.00
Support of Branch Stations	35,000.00
Permanent improvements, Branch Stations	15,725.00
Receipts of Branch Stations.....	36,899.17
Total.....	<u>\$185,809.17</u>

REPORT OF THE DIVISION OF AGRONOMY

The investigations of the Agronomy Division have included the soil survey; fertilizer experiments on different types of soil; the testing of different sources of plant food; crop rotations, and crop improvement work.

The soil survey work consists of classifying and mapping the soils of the State by counties. This work gives a permanent inventory of the kinds of soils, their area and location in the counties surveyed. It forms a basis for soil fertility recommendations and for future research in soil fertility and crop adaptation in the State. Up to date, approximately three-quarters of the State has been surveyed and mapped. Since several of the more important soil types of the State have been studied from the standpoint of plant food needs there has been an increasing interest in the reports of the soil survey. County agents, farmers, extension workers, teachers and business men are making more use of the reports that have been published and requests are being received for the extension of the work into other counties. During the past year Wilson and Northampton counties were completed and work was started in Burke and Rockingham. The soil survey work is conducted in co-operation with the Federal Bureau of Soils.

TECHNICAL SOIL FERTILITY INVESTIGATIONS

Efficiency of Nitrogenous Fertilizer Materials—Using millet as a test crop in pots, it is apparent that nitrate of soda is the most efficient form of nitrogen with other nitrates nearly equal. The manufactured tankages ranged widely from a value nearly equal to nitrate of soda to something like one-third of that value. Low grade raw materials produced very little growth in excess of the check.

Fertility of Muck Soils—Continuation of pot work with muck soils of the Blackland Station, Wenona, N. C., confirms the results of previous years. Liming the soil to complete neutrality does not result in greater growth of corn than does moderate liming. The efficiency of fertilizers is governed by the depth of liming in pot experiments. A greater benefit from the use of nitrate of soda and potash was observed when the subsoil was limed than with an acid subsoil. When this was applied to field conditions, heavy liming and deep ploughing were accompanied by injurious effects. Liming has no relation to the injurious effect of acid phosphate.

There is a marked similarity in the acidity and chemical composition of soils from several of the muck lands in the flatwood areas of the Coastal Plain. This is taken to indicate a similarity in some, at least, of their characteristic responses to treatment. It seems probable that the first limiting factor to crop growth on the deep mucks is excess of water in the soil. On certain types of muck lands already ditched it has not yet been possible to accomplish thorough drainage.

Reaction of Tobacco Soils as Influenced by Liming and Fertilization—Acidity determination on soils taken from the limed and unlimed portions of the fertilizer plats at Oxford show no consistent differences in soil reaction following the use of different forms of fertilizer.

The application of two tons of ground dolomitic limestone in four years has neutralized a fairly high degree of acidity and the results indicate that further additions will make the soil distinctly alkaline.

Miscellaneous Results—A few samples of ground limestone and marl have been tested to determine their value for soil improvement. The majority of samples submitted has represented a fairly high grade material for the purpose but the occasional low grade sample indicates the value of having these tests made.

Unproductive spots in otherwise productive fields present a persistent problem to farmers from all sections of the State. In a few instances it has been possible to recommend remedies as a result of chemical analysis. In the majority of cases improper drainage conditions, plant disease organism in the soil, or deficiency in fertilizer elements cause the condition noted. Excessive liming of sandy soils has been responsible for the unproductiveness of several fields.

FIELD EXPERIMENTS TO STUDY THE PLANT FOOD NEEDS OF CROPS ON DIFFERENT TYPES OF SOIL

During the year this work has been continued at all the branch stations and on nineteen outlying fields in thirteen counties. Four of these field experiments were conducted in co-operation with the Office of Soil Fertility Investigations of the Federal Bureau of Plant Industry.

Tobacco Branch Station—Oxford, N. C.

Tobacco Fertilizer Experiments—Field plat work for the purpose of studying the fertilizer requirements of tobacco has been continued at the Tobacco Branch Station. The field results continue to show the value of magnesia in overcoming sand-drown, and that muriate of potash is the most efficient source of potash, so far as yields per acre are concerned. It is planned to publish the results of the tobacco work now as soon as they can be put in shape for publication.

Mountain Branch Station—Swannanoa, N. C.

Wheat and Corn Fertilizer Experiments—In the growth of the crop on the upland soils of this farm, phosphoric acid and nitrogen have been the two most important elements.

Irish Potato Fertilizer Experiment—With this crop grown on bottom lands all plant food constituents are essential for most profitable returns. The use of sulphate of potash thus far has shown larger yields than either muriate of potash or kainit. Applications of lime to this crop have not proved profitable.

Crop Rotations—Two- and three-year crop rotations have afforded larger yields than the continuous growth of wheat or corn.

Coastal Plain Branch Station—Willard, N. C.

Although potash showed good profits, phosphoric acid and nitrogen were more essential to the production of oats and vetch on the soil of this farm.

Blackland Branch Station—Wenona, N. C.

Lime—In a study of the relative value of marl, limestone and hydrated lime on the muck soil of this station, it has been shown that limestone is

the most efficient. Two tons of ground limestone every three years has proved the best rate and frequency of application on this soil.

Irish Potato Fertilizer Experiment—The use of stable manure at the rate of four tons per acre in the drill gave a larger yield of potatoes than 1,000 pounds of fertilizer containing 8 per cent available phosphoric acid, 4 per cent ammonia, and 6 per cent potash. The commercial fertilizer was also applied in the drill.

Upper Coastal Plain Branch Station—Rocky Mount, N. C.

Crop Rotation—In the crop rotation experiments on this farm, where legumes were grown and taken off the land, other crops like corn, cotton and peanuts following them in the rotation showed a decidedly greater potash hunger than when the latter crops followed the same legumes plowed under.

Piedmont Branch Station—Statesville, N. C.

Fertilizer Experiments—Phosphoric acid and nitrogen have continued to be the two chief deficiencies of the Cecil soils of this station. Potash is essential in small quantities with all crops tried. The use of lime is necessary for most profitable crop yields, and especially so in the growth of red clover as this crop is a failure without it.

Acid phosphate continues to be a better source of phosphoric acid than soft phosphate rock in the fertilization of wheat.

In the field experiments activated sludge has given very favorable results as a source of nitrogen in the fertilization of cotton.

Crop Rotation—A two-year rotation of corn and wheat continues to show higher yields than the continuous seedings of either corn or wheat. In a three-year rotation of corn, wheat and red clover the crop yields are better than in the two-year rotation of corn and wheat.

RESULTS OF FERTILIZER RATIO AND OTHER EXPERIMENTS IN CO-OPERATION WITH BUREAU OF PLANT INDUSTRY

Sweet Potato Fertilizer Experiments in Carteret County—In the fertilizer ratio field experiments with sweet potatoes on Norfolk sandy loam soil in Carteret County, it was found that the use of nitrogen or phosphoric acid alone gave no increase, while potash gave a good increase in yield over no fertilizer. Among mixtures of two elements, ammonia and potash gave the highest yields, while those carrying only phosphoric acid and ammonia gave the lowest yields. From the results as a whole, potash is most effective, nitrogen coming second in importance. The use of phosphoric acid was least effective. Although the latter constituent is not very essential for increasing yield, it undoubtedly has some effect on the maturity and quality of the potatoes and should, therefore, be included in fertilizers used on this

crop. Based on this experiment, the best fertilizer mixture for potatoes on this soil should contain 5 to 6 per cent available phosphoric acid, 3 to 4 per cent ammonia, and 6 to 10 per cent potash. An application of 750 to 1,000 pounds per acre should be used.

Cotton Fertilizer Experiments in Cleveland County—In fertilizer field trials on Cecil sandy loam soil, the largest and most profitable yield of cotton was produced by the use of a fertilizer mixture containing 9 per cent available phosphoric acid and 6 per cent ammonia. Plats receiving this formula had 50 per cent of their cotton opened by October 9. No rust developed in any of the plats and there were no symptoms of potash-hunger.

Where nitrate of soda was used alone, 18 per cent of the cotton was opened by October 9, but where acid phosphate and nitrate of soda were applied a larger yield was secured and 35 per cent of the cotton was opened by this date.

The results secured with varying amounts of fertilizer were interesting, indicating the most profitable return from the use of 900 pounds to the acre.

Similar experiments were conducted with cotton on the Appling sandy loam soil in Cleveland County. The fertilizer mixture containing 9 per cent available phosphoric acid and 6 per cent ammonia; and the mixture containing 6 per cent available phosphoric acid, 6 per cent ammonia and 3 per cent potash produced the largest yields. The first mixture produced the largest amount of cotton opened early. Considerable rust appeared in the cotton on those plats receiving no potash. These plants shed their leaves badly and were completely defoliated at the time of the first picking. When nitrate of soda alone was applied only 35 per cent of the cotton was opened by October 9th, but 59 per cent was opened by this date when acid phosphate was applied with the nitrate of soda. In both cases the yield was practically the same. Nitrate of soda as the sole source of nitrogen in the mixed fertilizers took the lead on both types of soil.

Cotton Fertilizer Experiments in Cumberland County—Two formulas were outstanding for cotton production on the Wickham sandy loam soil. One contained 6 per cent available phosphoric acid, 3 per cent ammonia and 6 per cent potash, while the other analyzed 6 per cent available phosphoric acid, 6 per cent ammonia and 3 per cent potash. In a series of applications varying between 300 and 900 pounds of fertilizer per acre, the maximum application proved best. In a comparison of sources of nitrogen, nitrate of soda proved more effective than sulphate of ammonia or mixtures of nitrate of soda or sulphate of ammonia with dried blood, fish scrap, tankage and cotton seed meal. Muriate of potash was found more effective than either sulphate of potash or kainit.

Some Results From Outlying Fertilizer Field Experiments

The following are some of the more striking results from the regular fertilizer experiments conducted on outlying fields with farmers:

1. On a Norfolk sandy loam soil in Anson County, nitrate of soda proved a better source of nitrogen than either sulphate of ammonia, cotton seed meal or dried blood when all the fertilizer was applied to cotton at planting time. The next best carrier of nitrogen was sulphate of ammonia.

2. On a Georgeville silt loam soil in Anson County, nitrate of soda proved a better source of nitrogen for cotton than either sulphate of ammonia, cottonseed meal or dried blood. Potash up to 3 per cent in the mixture was found necessary for best returns.

3. Nitrate of soda proved the most profitable single carrier of nitrogen for cotton grown on Marlboro fine sandy loam in Sampson County. However, a mixture in which one-half of the nitrogen was derived from cottonseed meal and the other half from nitrate of soda gave a higher yield than nitrate of soda alone applied at planting time. The best returns were secured when all the nitrogen was derived from nitrate of soda, one-half being applied at planting time, and the remainder at the time of the first chopping.

An application of 600 pounds of fertilizer containing 6 per cent available phosphoric acid, 5 per cent ammonia and 3 per cent potash was more profitable than an equal amount of fertilizer analyzing 10-5-3 or 12-5-3. The use of 8-5-3 was more profitable than either an 8-3-3 or 8-7-3 goods. Increasing the potash beyond 3 per cent in the mixture was found to be unwise. An application of 900 pounds per acre of a 6-5-3 goods was not as profitable as 600 pounds of the same mixture.

4. Similar experiments with cotton on the Norfolk sandy loam soil in Sampson County indicate that nitrate of soda is a more profitable source of nitrogen than cottonseed meal, fish scrap or sulphate of ammonia. The application of 600 pounds per acre, in the drill, of an 8-5-3 goods gave better returns than an equal amount of either a 6-5-3, 8-7-3, 10-5-3, or 12-5-3 goods. An application of 600 pounds per acre of an 8-5-3 fertilizer was more profitable than 900 pounds of the same mixture.

5. In a study of the effects of varying amounts of potash upon yield of corn on Iredell loam soil in Davie County, a mixture of 10-6-2 was used as a base. The potash of this mixture was increased by increments of 2 per cent, and applied to separate plats until a mixture of 10-6-6 was reached. Each increase in potash was accompanied by sufficient increased yield to justify the application.

6. In a cotton fertilizer test on Norfolk sandy loam soil in Wayne County where 600 pounds per acre of an 8-5-3 fertilizer was used, the best results were secured when one-half of the nitrogen was supplied from cottonseed meal at the time of planting and the remainder supplied from nitrate of soda at the time of the first chopping. Among the four formulae tested, an 8-7-3 has given the best returns thus far.

7. When an application of 800 pounds of fertilizer was used on Alamance silt loam of Union County for cotton, the best results were secured when one-half of the nitrogen was derived from cotton seed meal and the remainder from nitrate of soda. The addition of potash to a 12-4-0 mixture, by increments of 2 per cent until the formula contained 6 per cent potash, gave profitable returns.

In a study of the potash requirements of corn on the same type of soil a mixture of 12-5-0 was used as a base. The addition of 2 per cent potash to this mixture resulted in a profitable increase, but increases of potash above this amount was not profitable.

8. With cotton grown on Portsmouth fine sandy loam soil in Chowan County, nitrate of soda was more efficient than either cottonseed meal or mixtures of cottonseed meal and nitrate of soda. They were compared in a mixture containing 10 per cent available phosphoric acid, 5 per cent ammonia and 3 per cent potash and applied at the rate of 600 pounds per acre. A mixture containing 6 per cent available phosphoric acid, 5 per cent ammonia and 3 per cent potash was better than similar mixtures carrying 8 or 12 per cent available phosphoric acid. Reducing the ammonia from 5 per cent to 3 per cent in the mixture was attended by a decided decrease in the yield of seed cotton. The use of 900 pounds per acre of a 10-5-3 mixture did not make as large yield as 600 pounds of the same mixture.

9. On Cecil sandy loam soil in Union County with cotton, nitrate of soda was a more efficient carrier of nitrogen than sulphate of ammonia, cottonseed meal, dried blood, or a half-and-half mixture of cottonseed meal and nitrate of soda. The application of 600 pounds per acre of an 8-5-3 mixture gave a larger yield of cotton and greater returns than a similar amount of a 6-5-3 goods.

10. With cotton grown on a Cecil clay loam in Mecklenburg County, in which mixtures containing from 6 per cent to 12 per cent of available phosphoric acid, 5 per cent ammonia and 3 per cent potash were tried, the mixture with the higher percentages of phosphoric acid produced the larger and most profitable yields. Varying the ammonia percentage progressively in the mixtures from 3 to 7 per cent did not appear to materially affect the yields of seed cotton. Nitrate of soda proved a more efficient carrier of nitrogen than cottonseed meal on this soil.

11. With wheat grown on a Rowan County farm, it was found that the use of 600 pounds per acre of a fertilizer mixture containing 12 per cent available phosphoric acid, 5 per cent ammonia and 4 per cent potash was more profitable than similar mixtures containing less potash.

12. In the growth of cotton on Norfolk sand in Richmond County it was found that the use of an 8-5-3 mixture with one-half of its nitrogen derived each from nitrate of soda and cottonseed meal was better than one in which all the nitrogen came from either nitrate of soda, cottonseed meal or sulphate of ammonia.

CROP IMPROVEMENT STUDIES

Cotton Breeding—Cotton breeding work is being carried on at three of the station farms—Central, Edgecombe and Iredell farms. Pedigreed strains of Mexican Big Boll are grown on all these farms and these strains are being further improved by plant-to-row selections. At the Edgecombe farm strain 18-2-7 was outstanding in yield and quality and was very promising last year, while strain 6-1-9 at the Central farm was far superior to all other strains. Several acres of these strains are being grown this year. These strains of Mexican Big Boll are being bred to meet the local demand for uniform inch to inch and a sixteenth cotton.

Date of Planting Cotton—Tests to determine the best date of planting cotton at the Upper Coastal Plain Branch Station were carried on. Seedlings made April 19 and 30 proved best and gave approximately the same

yields. Seedlings made on April 9th gave a very poor stand. May 10th planting gave a reduced yield. The work was continued in 1925.

Early versus Fresh Preparation of Land for Cotton—One series of plats were broken and prepared for planting cotton two weeks before planting time, while a similar series was broken fresh at the time of planting. The yield of the early prepared plat was 1,350 pounds of seed cotton, and that of the fresh prepared, 1,143 pounds of seed cotton per acre. The fresh preparation gave a little better stand in spring of 1925.

Treatment of Cotton Seed—Cotton seed were rolled in nitrate of soda and compared with untreated seed at the Edgecombe farm in 1924. The yield from the nitrate of soda treated plat was slightly less than the untreated plat. At the Central farm, seed were treated in the following ways: Delinted with sulphuric acid, rolled in nitrate of soda and rolled in wood ashes. The acid delinted seed came up about five to seven days earlier, were stronger and showed less disease. The final yield was larger than from any of the other plats. The seed rolled in wood ashes germinated about the same time as the check plat, but yielded a little more. Seed treated with nitrate of soda were the latest coming up and yielded considerably less than the check.

This work is being continued this year. Machine delinted seed were also used in the work at the Edgecombe farm in 1925. Acid and machine delinted seed gave earlier germination than other plats. The acid delinted plat was freer from disease. The seeds rolled in soda were late germinating and poor stands were secured.

Cleaned versus Uncleaned Cotton Seed—Cleaned and graded seed produced 1,452 pounds seed cotton against 1,215 pounds where the seed were not cleaned.

Cotton Spacing Test—Spacing tests were conducted on the Central, Upper Coastal Plain and Piedmont Branch Stations. Close spacing appears to be best in soils where the growth is not large. On the Upper Coastal Plain farm, there was very little difference between 8-, 12- and 18-inch spacings. No thinning gave a slightly reduced yield. Close spacing was accompanied by greater shedding of early fruit during the past year.

Soybean Breeding—The soybean breeding work for high oil content has been discontinued and the data is being prepared for publication. In the study of pedigreed lines of soybeans there was more variation in yield than in oil content. The few high oil strains that were isolated were not very productive. High yield of oil was therefore determined by high yield of seed rather than high oil content. The selection of a much larger number of plants should find a combination of high yield and high oil for there is nothing to indicate that these characters would not combine.

Plant-to-row selections from pedigreed strains of soybeans did not give an increased yield. However, some strains of the Herman variety were found to be mottled much worse than others.

Several soybean hybrids have been isolated and two of them look quite promising.

Variety tests of soybeans were conducted at the Central and Mountain Stations in 1924. In a three-year average on the Central farm the Tokyo, Herman and Mammoth Yellow were the leading seed producers, while Oootan and Laredo were the best hay varieties. At the Mountain farm the Herman, Midwest and Austin in the order named, were the leading seed producers during a four-year period. Variety tests are also being conducted on the Piedmont, Upper Coastal Plain, Lower Coastal Plain and Blackland farms during the season of 1925.

Rate of seeding tests are being conducted on the Central farm with Oootan, Laredo and Herman varieties.

Several new varieties are being tested for the first time on some of the farms. One or two are quite promising.

Winter Legumes

Source of Crimson Clover Seed—Fifteen strains were planted on the Central farm in the fall of 1924. Four of these were Southern grown seed from different states, while the others were from foreign countries. Two of the imported strains were equally as good as American grown seed, but some of them were inferior to American grown seed.

Vetch Varieties—Hairy, Woolly Podded, Hungarian and Purple vetch were planted in the fall of 1924. The Purple vetch was killed by freezing. The others stood the winter well. There was very little difference in the growth made by the Hairy and Woolly Podded vetch. The Hungarian vetch made considerably less growth than the other two.

Lespedeza Strains—Kobe and Tennessee strain No. 76 were grown in 1924. The Kobe made a slightly larger growth. The Kobe reseeded itself in the spring of 1925, while only a few scattering plants of Strain No. 76 were secured. The Kobe made a fair growth during the dry summer, much better than Strain No. 76.

Sorghum Breeding—Sorghum selection work has been carried on with the Honey variety for three years. One pedigreed strain gave a very heavy tonnage, and also a high sugar content. This strain has been increased and the seed distributed to several farmers. On account of its heavy tonnage this strain is also being used very successfully for silage. Its yield has been considerably heavier than corn.

Adams Projects in Plant Breeding

The following are some of the findings during the year on two Adams Projects with cotton:

Project No. 14—The plantings were made from crosses between fuzzy and naked seeded cotton plants. The F/2 generation is being grown this season and to complete the studies of inheritance between fuzzy and naked coats of cotton seed. Along with this study plantings have been made which will give some information on the fuzzy tip character. In previous studies the naked seed with tufted tip has given a larger amount of lint per seed than the true naked seed. It is a matter of importance to know just how this fuzzy tip character is inherited.

Several F 1 plants (naked crossed on fuzzy seeded plants) were grown in 1924. Seed from these were planted in 1925 to determine the inheritance of naked seed character. Work is also being carried on with a naked seeded Cleveland strain to determine whether a high percentage of lint can be secured from a naked seeded cotton.

Project No. 15 The data on No. 15 has been collected and put in shape for publication. It is suggested that this be combined with some of the other inheritance studies into a technical bulletin during the current year.

Summary of Crop Results

1. Delinting cotton seed with sulphuric acid or by machinery hastens germination.
2. Delinting with sulphuric acid reduces disease in the seedlings.
3. Rolling cotton seed in nitrate of soda delays germination, reduces the stand, and in this way reduces the yield.
4. Selecting soybeans for high yield is more important than for high oil.
5. High oil and low protein content are usually associated, and vice versa.

Small Grain and Corn Work

Work with small grains is being conducted on the Mountain and Piedmont farms. The work assumes the form of variety tests to determine the highest yielding variety of the wheats commonly grown in North Carolina. No outside varieties have yet been introduced. The scheme calls for a five-year period of these tests. Then the outside varieties will be tested in comparison with the highest yielding varieties in the State.

On the Mountain Station five varieties are being tested. Two of the leading varieties, Fulcaster and Leap's Prolific, are being grown in separate plats on upland and bottom soils to determine the relative value of these lands for wheat growing. This work has been conducted for three years. During the three-year period Leap's Prolific has yielded best on the uplands, and Fulcaster has yielded best on the bottom lands.

A similar test is being conducted on the Piedmont farm. This test includes the same five varieties of wheat and, in addition, two varieties of rye, three of barley and three of oats. The test is being conducted for the same purpose and for the same period of time as on the Mountain farm: (1) to determine the highest yielding variety of wheat, rye and oats of those commonly grown in Piedmont North Carolina; (2) to compare barley with oats and rye for temporary pasture and for the production of grain and straw. The average results for the past three seasons indicate that Fulcaster, Gleason and Purple Straw are the best varieties of wheat for the Central Piedmont section. Abruzzi rye continues to lead as a cover crop and seed producer. The Appler and Fulghum oats are still standard varieties for this section.

Seed corn selection work is being conducted on all the farms. Saving remnants from the ear-to-row method is the scheme followed. The remnants from the highest yielding rows are planted the following season in alternate rows with field selections and the field selected rows detasselled

to insure cross fertilization. Seed saved from the detasselled rows is planted in a general seed patch from which is selected seed for planting the general field crop on the farm. If the amount of seed from the detasselled rows is sufficient, the general crop is planted from this seed. This is the scheme now being followed on all the Station farms except the Blackland farm. That community has not yet decided upon the best variety for the land so a variety test is being conducted there this season in an effort to determine this point. On the Coastal Plain farm selections are also being made with early market corn. Norfolk Early Market is the variety used. Iowa Silver Mine, an early field corn from Iowa, was planted on the Mountain farm to see whether there would be any advantage in growing this variety as a market corn.

The results on all the farms in the western part of the State, including the tobacco farm, are practically a failure on account of the extreme dry weather prevailing in that part of the State the past season. A strenuous effort is being made to save enough seed to continue the work next season, so as not to lose the entire effect of past selections.

C. B. WILLIAMS, *Head, Department of Agronomy.*

REPORT OF DIVISION OF ANIMAL INDUSTRY

EFFECT OF OIL EXTRACTED PEANUTS UPON REPRODUCTION AND LACTATION OF SMALL ANIMALS

The use of cereals alone in the ration without whole milk or fresh cabbage did not give successful results. The addition of 5 per cent alfalfa meal bettered the situation, young were reared through the third generation. No fourth generation was obtained. Without alfalfa leaf present only a second generation was obtained.

The ash of the equivalent amount of alfalfa meal was added to the cereal ration with the result that all the rats died. This tends to indicate that the favorable influence does not lie in the ash of the alfalfa leaf. It is in the organic factor.

Similarly, the ash of whole milk and of cabbage is being used with rather poor results.

The factors present having such remarkable influence are so far unknown.

EFFECT OF HEAVY COTTON SEED MEAL FEEDING UPON REPRODUCTION AND LACTATION OF DAIRY CATTLE

Approximately five years ago twenty head of cattle on heavy cottonseed meal feeding kept on a lot of four acres of ground produced apparently normal living calves. In this lot, these cows had access to small amounts of grass which they kept cropped short. This herd was later moved to a small closely fenced lot where no green grass was obtained with the astonishing result that abortions, dead under-weight calves and living blind calves were obtained. The cows also gradually lost weight, became stiff and had edema. This condition continued into severe fits or spasms from which they ultimately died—other cows had fits occasionally and became partially blind, some permanently blind. Some had severe spasms immediately after or at the time of parturition.

Such observations lead to the view that perhaps there were nutritive deficiencies in the heavy cotton seed meal and hull ration as fed. (Hulls being fed for roughage.) It was thought that these effects were not wholly due to "toxicity" or to a toxic principle in the cotton seed meal. Perhaps the small amount of grass on the four-acre plot had "protected" these cows from deficiency effects of the heavy cotton seed meal feeding.

Hence, definite supplements such as crude casein, calcium, carbonate and butter fat were added, later steam bone meal, cod liver oil and water soluble B supplied in various substances as well as bright green alfalfa meal in various combinations with the cottonseed meal were also fed.

The effect of such supplements upon heavy cotton seed meal feeding to dairy cattle is profound. More cottonseed meal has been consumed throughout the past two hot seasons than previously. No deaths nor spasms have occurred. Living calves more approximately of average weights have been born and these cows have produced more milk upon which these same calves have been raised.

To date the more complex nutritively balanced rations of heavy cottonseed meal have given the better results. This would indicate that for dairy cattle the proper supplementing of heavy cottonseed meal feeding is not a

simple matter and will require considerable more work to ascertain the principal deficiencies. So far water soluble B, fat soluble A, and calcium have shown beneficial results where all are supplied in the ration. What practical feeds to add to the cottonseed meal that will best supply these and possibly other deficiencies remain to be determined. The proteins in cotton seed meal appear to be of good quality for reproduction and lactation.

Other important problems so far little touched upon, are the effect of these supplements to cotton seed meal upon the growth of calves and heifers.

RESULTS OF SOFT PORK INVESTIGATIONS FROM INDIVIDUAL FEEDING

After five years of work, from feeding 35 to 40 pigs, individually, in five different experiments, upon rations made up largely of peanuts, it has been found that there is a definite relation between the amounts of oil ingested, during the fattening period, and the condition of the carcasses of the pigs when slaughtered at good marketable weights ranging from 171 to 227 pounds. In fact the data show that the quantitative variation of oil, consumed in the ration, will be indicative of the condition of the carcasses after slaughtering. While these lines of demarcation are not clearly discernible when physical gradings alone are made, yet the chemical data do show very clearly that there is a gradual softening effect on those pigs receiving the larger amounts of peanuts. In these five trials varying amounts of peanuts were fed to pigs of 40, 57, 71, 90 and 92 pounds average initial weights.

Second, it was found that hardening feeds given following the softening peanuts produced harder hogs than when the hardening feeds were fed in the same relative amounts at the same time that the peanuts were given. This fact is due to the more rapid laying on of fat when a hog gets larger, say from 125 to 130 pounds in weight. Growth has then decreased and the more rapid deposition of fat begun.

Third, it was found that the size of a hog when killed also influenced hardness. A tendency to softness occurred in those hogs that were killed at lighter weights after being fed hardening feeds, under the most favorable conditions, subsequent to the softening feeds. For example, a hog killed at 140 to 160 pounds in weight will be softer than a 200-pound hog, since smaller hogs are naturally softer as they are more agile and active at this age. At these weights, these sized hogs, do not store as much fat in their body as a 200-pound hog even though both are on hardening feeds. It is also the character and condition of the stored fat in the adipose tissue cells which determine whether a hog is soft, oily or hard. This depends largely on the classes of feed fed.

CO-OPERATIVE SOFT PORK INVESTIGATIONS

The number of State Experiment Stations co-operating in this work has increased from four to eight with the prospects of at least three more taking up the work next year. Approximately 3,500 hogs have been slaughtered during the five years that this work has been under way, and some definite results have been obtained regarding certain "softening

feeds." However, the work at this Station has been confined largely to feeding experiments with peanuts with the following results:

1. Peanuts grazed or self-fed in dry lot with or without minerals to pigs starting at weights ranging from 85 to 115 pounds and making gains of approximately 40 pounds or more on that feed through a period of approximately six weeks will not produce firm carcasses at the usual market weight of 200-225 pounds attained by subsequent feeding of corn with tankage after the peanuts.

Results have shown, in fact, that gain on corn with tankage up to approximately 120 pounds, this maximum being produced during a feeding period of approximately 16 weeks duration, following gains of 40 pounds or more on peanuts usually will not produce hard or medium hard hogs. As the gain on peanuts increases the subsequent gain on corn with tankage necessary to produce a certain degree of firmness likewise increases.

Technical Reports: Confidential report of Co-operative Soft Pork meeting held at Atlanta, Ga., May 5, 6 and 7, 1925:

Cost of Raising Pigs to Weaning Time—(8 Weeks)

Data have been collected on this project at the Swine Research Farm at Raleigh, and at three of the Test Farms, namely, Piedmont, Blackland, and Upper Coastal Plain. Approximately ten sows are maintained in each herd, at the four different farms. Weights for each sow and litter are recorded at both farrowing and weaning time (8 weeks), and an accurate account kept of the amount and kind of feed fed from the time the sow is bred until she weans her litter. Other information, such as age of sow, sex of pigs, breed, age of boar, etc., is tabulated for assistance in tabulating the results when ready to publish.

Technical Reports: None.

Value of Pasture for Swine

Five lots of 8 pigs each were used in this experiment for the purpose of comparing:

1. Pastures versus dry lot.
2. Permanent pasture versus temporary pasture.
3. Limited feeding versus full feeding on pasture.
4. Time required for a 40-pound weanling pig to reach 200 pounds when fed under the above conditions.

Work during one year indicates that although the pigs receiving a limited grain ration (3 per cent) on pasture, required a longer time to reach the required weight, they made more economical gains than those receiving a full ration. The pigs on temporary pasture made slightly cheaper gains than those on permanent pasture.

The gains made, by pigs that were self-fed on pasture, were more expensive than those made by pigs self-fed in a dry lot when pasture was charged at \$15.00 per acre.

Technical Reports: None.

"Hogging Off" Corn and Soybeans Grown Together

Seventy fall farrowed pigs were used in this experiment. Their average initial weights was 53 pounds. The yield of the crop was estimated at 30 bushels of corn and 5 bushels of soybeans per acre. The experiment continued for 80 days, and each acre of crop produced 523 pounds of pork, when supplemented with 113 pounds of fish meal and 16 pounds of mineral.

Fish Meal Versus Soybean Meal as Protein Supplements to Corn for Fattening Pigs

Two experiments were conducted on this project during the past fiscal year for the purpose of determining the comparative value of Fish Meal versus Soybean Oil Meal as protein supplements to corn when self-fed, free choice to fattening pigs in a dry lot. The work was done at the Blackland Test Farm and 136 pigs were used in the two experiments.

The results indicate that the pigs receiving Fish Meal will make more rapid gains, and more economical gains, than those receiving Soybean Meal, even though Soybean Meal can be purchased for less money than Fish Meal. It is very palatable and when fed under the "free choice" system, the pigs consume more than is necessary to balance their ration, and since corn has been cheaper than either of the protein supplements, the excessive amounts of Soybean Meal eaten have increased the cost of gains materially.

HERD DEVELOPMENT

Coastal Plain Branch Experiment Station and Mountain Branch Experiment Station

In this study to determine what increase in production will occur in succeeding generations where selected well-bred sires are used, the daughters of Rumina's King, the second sire to be used, are now being tested. Every daughter of Rumina's King put on test has produced over 400 pounds of fat. Three of them completed Silver Medal records this past year, and one of them as a four-year-old missed a Gold Medal by 14 pounds of fat. His daughters in milk have produced an average higher than their dams at the same age. For the purpose of making this study more thorough all the production records for daughters of Eminent 19th, for their dams, and also for their daughters sired by Rumina's King, have been organized. A complete herd book containing pedigrees, service, produce, and production records has been made out for Coastal Plain and Mountain Stations. Individual service records have also been made out. The service record of each bull is being tabulated so that a thorough analysis is being made for breeding efficiency.

R. H. RUFFNER, *Head, Department of Animal Industry.*

R. S. CURTIS, *In Charge, Research Work.*

REPORT OF DIVISION OF POULTRY

INTRODUCTION

The poultry experimental work of the year included studies of poultry diseases and their control, nutritional studies and breeding experiments. The work is being done at the Central Experiment Station, Raleigh, North Carolina, at the Mountain Station, Swannanoa, North Carolina, and at the Coastal Plain Station, Willard, North Carolina.

SEPTICAEMIC DISEASES OF POULTRY

Considerable attention has been given to the study of fowl typhoid, a disease which has given serious loss during the past few years. More than fifty outbreaks of this disease have been studied in the field and laboratory. Vaccinations with both stock and autogenous vaccines have been tried in each of the outbreaks and their control value favorably established.

Recent studies with the European organism causing Klein's disease indicate that it is identical with the organism causing fowl typhoid in America.

Comparative studies have also been made between fowl cholera and fowl typhoid. Both diseases are septicaemic with very similar symptoms and post mortem findings, though the organisms belong to different groups. That of fowl cholera belongs to the pasteurella group, and that of fowl typhoid to the colon-typhoid group. More detailed results of these findings are contained in Technical Bulletin No. 27.

MISCELLANEOUS LABORATORY STUDIES

The laboratory receives a large number of specimens from different sections of the State for diagnosis. During the past three years 1,700 complete autopsies and 600 hospital cases have been received for diagnosis and study. This material is of inestimable value in the working out of parasitic, indexes, mortality expectancies, prevalence of disease, and its economic importance.

During the fall and winter months when material is available studies have been continued upon contagious respiratory diseases. During the spring months studies are made of colon-typhoid intermediates as they affect brooder and range chicks.

INHERITANCE OF EGG PRODUCTION

This work has consisted of isolating low and high producing strains of White Leghorns and late winter matings to determine the inheritance of egg production. Hens from a low-producing strain were mated with a male from a low-producing strain. The daughters from this mating were low producers. The male from the low-producing strain was then mated with hens from both high- and low-producing strains. The pullets from these matings are now being tested.

RELATION OF PHYSICAL CHARACTERS TO EGG PRODUCTION

This study has been conducted with Rhode Island Reds, Barred Plymouth Rocks, and White Wyandottes for the purpose of developing high quality

egg and meat production in the above dual purpose breeds. Consideration is being given to physical characters which are associated with high, medium and low production. The work is being done on the Central, Coastal Plain and Mountain poultry plants. The results from selecting high quality egg and meat strains are gratifying. The average egg production has been increased from 72 eggs per year to above 150, some hens producing close to 300 eggs per year.

FISH MEAL VERSUS MEAT MEAL FOR EGG PRODUCTION

Fish meal and meat meal have been compared for egg production when fed to Rhode Island Reds. The results of the year ending October 31, 1924, indicate that fish meal is equal to meat meal when fed on a pound for pound protein basis. Each flock averaged 47 per cent production for the twelve months.

EFFECTS OF INCREASING THE FEEDING HOURS BY THE USE OF ARTIFICIAL LIGHT

Beginning with the pullet year, hens have been subjected to 36 consecutive months of 14 feeding hours per day. The extra feeding hours are secured by the use of electric lights. The present year marks the completion of the second three-year period. The results show conclusively that a hen must have a rest period between each year of exposure to the extra feeding hours in order to replenish her depleted stores of vitamins, minerals, etc. It is not wise to subject hens to the extra feeding time for more than five months of the year. The time between November 1st and April 1st is suggested. A sudden reduction of the feeding hours will be accompanied by premature molting, and irregular lighting will give unsatisfactory results.

COMPARATIVE VALUE OF CONDENSED MILK, MEAT MEAL AND FISH MEAL FOR YOUNG CHICKS

Extensive feeding tests have been conducted to study the relative value of condensed milk, meat meal, fish meal and dried milk for young chicks between time of hatching and eight weeks of age.

The results indicate that these animal feeds are equal in value when fed on the basis of protein content. At the end of eight weeks 82 per cent of all chicks were alive. The pens fed meat meal, condensed milk, and dried buttermilk had reared 83 per cent of their chicks, and those receiving the fish meal ration contained 80 per cent. When all of the feeds are considered, it required an average of 3.4 pounds of feed to produce a pound of gain in the chicks. There was required 3.7 pounds of meat meal, 2.7 pounds of condensed buttermilk, 3.8 pounds of dried buttermilk, and 3.5 pounds of fish meal, respectively, for each pound of gain.

THE EFFECTS OF DIRECT VERSUS TRANSMITTED SUNLIGHT UPON THE HEALTH AND GROWTH OF YOUNG CHICKS

Beginning at the time of hatching one group of chicks was given direct sunlight, while the other received sunlight through glass windows. Observations were made during a period of eight weeks. The lot receiving trans-

mitted light showed weakness in vitality at the end of five weeks, while those receiving direct sunlight continued to grow normally.

POULTRY FEEDING STUDIES WITH MILK AND MEAT MEAL

This work is conducted for the purpose of comparing the efficiency of milk and meat meal for rearing and egg production in poultry. The work is conducted with S. C. Rhode Island Reds at the Coastal Plain Branch Station. The original flock used in this work was divided equally according to number, health, production and breeding. One lot receives milk as the sole source of animal feed, while the other receives meat meal. The comparison is to cover a period of several years, each lot receiving replacement birds from the young of its group. In this way the accumulated effects of the two feeds will be noted. The first year's work closed on October 31, 1925. During the past season the milk-fed pullets began laying seventeen days earlier than those fed meat meal. The milk-fed chicks grew off better, reared a larger percentage, and developed better color. A larger percentage of the milk-fed hens went above the 200-egg production mark. It should be kept in mind that many factors may enter in to influence a project of this kind; the results given above represent a progress report for one season's work.

FATTENING BROILERS

Fattening experiments have been conducted at both the Mountain and Coastal Plain Stations during the past year. The results show that hot weather will interfere with gains in weight. The feeders must be kept cool for best results. A simple ration of equal parts of ground corn and oats, with two pounds of milk to one pound of mash gave most economic gains. The milk and mash were made up fresh at each feeding. The results indicate that it pays to feed three times a day; that milk-fed broilers will bring from five to seven cents premium over broilers fed the ordinary way. It will pay to fatten broilers even though no extra price is paid because of the quicker gains, heavier broilers, and the better pleased customers. Local markets have proven best since the loss from shrinkage, coopage, and freight often results in lower profits on markets at a distance.

INFLUENCE OF CLIMATE UPON EGG PRODUCTION

This work is planned to compare the production performance of hens at Winnipeg, Canada, with similar stock at Raleigh, North Carolina. The second three-year section of this work was completed the first of November, 1925. The hens at Raleigh have averaged 25 to 35 eggs per year more than those at Winnipeg. The hens at Raleigh have a looser flesh and are one pound heavier at the end of the year than the hens grown in the latitude of Winnipeg.

B. F. KAUPP, *Head, Department of Poultry.*

REPORT OF DIVISION OF ZOOLOGY AND ENTOMOLOGY

BIOLOGY OF THE GENUS *DIABOLICA* CORN ROOT WORM AND MELON BEETLES

The study of the relation between rotation and injury by the corn root worm has been continued. Data have been secured from the rotation plats of the Division of Agronomy on the various sub-stations. The past year was a season of very serious injury by this pest, and data for this year do not confirm previous data that rotation is a factor of great importance in the control of this pest. The work must be continued for a number of years, however, before conclusions worthy of consideration can be drawn.

Search for an effective soil repellant that might be used against the corn root worm has been continued, but thus far all materials tried have fallen into three classes: (1) Those that were absolutely ineffective; (2) those that were effective for a limited period only, and (3) those that were injurious to the germinating seed.

BIOLOGY OF THE HOMOPTERA, LEAF HOPPERS

Work in this project falls naturally under three major divisions: (1) Bibliographical, (2) Systematic and Morphological, and (3) Economic.

The bibliography, numbering more than 3,000 titles, has been checked and rechecked, so that there remains less than 100 titles which have not been studied, and most of these titles are of minor importance. The bibliography is now being assembled for publication. The index now numbers more than 100,000 titles, and is, so far as known, the only place in the world where there is an index to all the species of this group. This has been of great value to the work of this department, and also to other entomologists in many parts of the world. During the past year specimens have been received for determination from the following States: New York, Illinois, Connecticut and Oklahoma, and from the following foreign countries: Cuba, Panama, Argentina, Mexico and British East Africa. The index will also be of inestimable value in connection with the preparation of the catalog of Hemiptera of the World. The entomologist of this Station is a member of the editorial board for this publication, and this index will be used by the authors of the various sections in checking their manuscript before publication.

During the past year considerable attention has been devoted to the injury of two crops of leaf hoppers. In the spring of 1925 serious damage was done to cotton in several sections of the State by two species. The life histories of these species are under observation. A number of species are very injurious to pasture lands in the mountains. Preliminary studies were made several years ago, and these were checked again this year. The studies made this year will be specially valuable because they were made in a season characterized by extremely dry weather.

Survey studies have also been made of the grape leaf hopper, potato leaf hopper, the soybean leaf hopper, and the peanut leaf hopper. All of these insects are of major economic importance to the crops concerned, and detailed studies will be made of some of them another year.

THE CORN EAR WORM

Work is being done in co-operation with the Bureau of Entomology in the study of the Corn Ear Worm. For the present the project is being confined to a study of the difference between varieties of corn as far as damage done by this insect is concerned.

During the past year the following technical papers have been prepared or published:

The Cercopidae of Cuba (with S. C. Bruner). Psyche XXXII.

The Membracidae of Cuba (with S. C. Bruner) Bulletin Brooklyn Entomological Society, Vol. XX, in press.

The Fulgoridae of Panama. Bulletin Museum of Comparative Zoology, in press.

Z. P. METCALF,
Head, Department of Zoology and Entomology.

REPORT OF DIVISION OF PLANT PATHOLOGY

SOYBEAN DISEASES

Satisfactory progress has been made in this project. The results on the bacterial pustule disease have been published in Volume 29 of the *Journal of Agricultural Research*. This disease has been found to be distinct from bacterial blight, previously described from this Station and from bacterial diseases of soybeans which have been described in Japan and Manchuria. It is, however, very closely related to, yet distinct from, bacterial blight of garden beans. The disease appears to be confined to the foliage where it produces pustular outgrowths and is undoubtedly seed-borne.

The work with the brown leaf-spot disease and with anthracnose is essentially complete and will be submitted for publication during the year.

A number of soybean diseases which are most prevalent in the State are seed-borne. An effort has been made to determine the effect of seed treatment with chemical disinfectants in controlling these diseases. Two-year-old Mammoth Yellow seed were used. Allowing the seed to reach two years of age before planting reduces the amount of bacterial leaf-spot and mildew, but did not completely eliminate it. The application of formalin solution, corrosive sublimate solution and Bayer Dust to two-year-old seed caused no appreciable reduction in the amount of bacterial leaf-spot and mildew which appears on the plants. Formaldehyde greatly reduced the stand of plants from these two-year-old seeds, while mercuric chloride solution and Bayer Dust greatly increased the stand. The stand of plants on the two-year-old untreated seed plot was very poor, while that on the plot planted to similar two-year-old seed after treatment with Bayer Dust was but little less in amount than that of the one-year-old seed plot. Apparently the compounds containing mercury increase the germination of two-year-old seeds of soybeans.

Work done at this station several years ago has led us to believe that the fungus which causes wilt of cowpeas is specifically identical with that which causes wilt of soybeans, and that for this reason soybeans should not follow cowpeas on a field where the cowpeas have suffered from wilt. During the past season, 48 varieties and selections of soybeans were planted on land which last year bore a crop of soybean plants that were badly diseased by wilt. Not a single soybean plant in any variety was found which showed any wilt symptom, while cowpeas planted as checks were badly diseased. The explanation of this unexpected result is not apparent. It may be due to the presence of strain difference of a physiological nature within the species of the fungus which causes cowpea wilt. It does not appear that yearly variation of temperature or rainfall can account for complete absence of wilt on the soybeans. Incidentally several plants of the cream Crowder cowpea were found which appeared to show a marked degree of tolerance to the wilt fungus. Seed from these plants were saved separately with a view to testing the resistance of their progeny next season.

In some sections of the State, southern root rot caused by *Sclerotium Rolfsii* is the cause of considerable loss to soybeans. This fungus is not

seed-borne, but persists from year to year in infested soils. In an attempt to find some economical soil treatment which might reduce the incidence of this disease, ground limestone was applied to infested soil at the rate of one and one-fourth tons and two and one-fourth tons per acre. This treatment neither reduced nor increased the amount of disease occurring on infested soil.

A new leaf-spot disease of soybean was found within the past few weeks. This leaf-spot is distinctive in character and may readily be distinguished from other soybean leaf-spots by microscopic characters. It is caused by a species of fungus belonging to the genus *Cercospora*. The spots, which vary in size up to 5 mm., have light gray centers which are surrounded by narrow dark brown or red borders. This disease has so far been found only on Ootootan and Laredo, and was very abundant on the latter and scant on the former. In its pathological aspect and in the morphology of the causal organism, this disease strongly resembles one which Miura described in 1921 on *Glycine hispida* and *Glycine soja* growing in South Manchuria. Miura regarded the casual fungus of the Manchurian soybean disease as a new species and gave it the name *Cercospora Daizu*. Whether or not the fungus found in North Carolina should be referred to this species remains to be determined.

Strawberry Leaf Scorch—The work on this project has been completed during the year. A technical report supplementing that which appeared in Volume 39 of the *Journal of the Elisha Mitchell Scientific Society* is being prepared. This will deal with the relationship of conidial, spermatogonial and apothecial stages in the life history of the casual fungus.

The field studies on control have been completed. An account of this disease including such phases as its descriptions, the life history of the fungus, its spread and its control, should be prepared for publication for distribution to strawberry growers of Eastern North Carolina.

Control of Seed-borne Infection—A portion of the work done on this project has been written up and published as Technical Bulletin 26, entitled, "Studies on Treatment of Cotton Seed." Part I on this bulletin describes the experiments and gives the data obtained in various tests performed in the effort to find the proper time and temperature relation for killing the anthracnose fungus without killing the cotton seed. A machine for treating seed in quantities of approximately a bushel is described and illustrated. With this machine the effective treatment for complete elimination of cotton anthracnose from infected seed without serious diminution of germinability consists of 20 to 24 hours of desiccation at 60-65° followed by 12 hours of heating at 95-100° C. This period of heating may be shortened considerably—cut in half approximately—but with the shorter treatment, a small amount of anthracnose—considerably less than 1 per cent—remains viable. This small amount of anthracnose is negligible if seed are to be treated every year.

A field test with treated seed during the season just past gave remarkably encouraging results. Seed which had been treated to destroy anthracnose withstood the cold, unfavorable weather which followed planting much more successfully than untreated seed. From 50 to 75 per cent of the

seedlings from untreated seed planted on nearby plots died largely from an attack of anthracnose following cold weather, and the greater portion of the general acreage which was planted early had to be reseeded because of the resultant poor stand. Sickly seedlings were difficult to find on the plots planted to treated seed, and in no case could anthracnose spores be found on the few which were present while anthracnose spores were abundant on 90 to 100 per cent of the sickly seedlings found on untreated plots. Although the seedlings on the treated plots made but little growth during the unfavorable cold weather, they remained remarkably healthy and possessed strikingly good color in comparison with seedlings from untreated seed.

Part II of Technical Bulletin 26 presents certain data pertaining to germination of cotton seed and viability of the anthracnose fungus as influenced by desiccation and by storage in inert gases. Storage of infected seed over such desiccation chemicals as H_2SO_4 and CaO prolongs life of the anthracnose fungus. This result shows that the death of the anthracnose fungus when infested seed are treated with dry heat is not due to the desiccation accompanying the treatment, but to the direct effect of the heat on the fungus protoplasm. The storage of cotton seed over concentrated H_2SO_4 and dry CaO induces a condition of secondary dormancy in many of the seeds. Storage of infected seeds in hydrogen or carbon dioxide does not free the seeds from anthracnose.

Special studies are in progress dealing with certain changes in enzyme activity resulting from the treatment of cotton seed with dry heat. These tests are now nearly finished and the data obtained will soon be offered for publication.

Wheat Take-All—The studies on the control of this disease have been conducted in co-operation with the Office of Cereal Investigation, United States Department of Agriculture. A large number of varieties have been planted in studies on varietal resistance. Head selections have been made and planted in head-to-row plots. Certain of these have shown marked resistance so that head selections have again been made for planting in the coming year. The results thus far indicate that it will be possible to secure resistant strains from varieties of excellent growing value.

Dew Berry Anthracnose Control—For several seasons this Station has been co-operating with the Office of Fruit Disease Investigations, United States Department of Agriculture, attempting to control anthracnose of dew berries. During the past summer this disease has taken a toll of approximately 15 per cent of the crop throughout the Sandhills. In those fields in which the experimental work was done very satisfactory control was accomplished. This was done by the judicious employment of two measures whose use was based on life history studies of the causal fungus. It was found to be necessary first of all to remove and destroy, immediately after harvest, all above-ground-growth. This was followed by the application of sprays at critical times. On the farm of Mr. Chas. C. Jones, Cameron, North Carolina, one berry in every 180 was diseased in the sprayed portions, and one in every 14 in the unsprayed. A total of only nine diseased berries was found on 16 consecutive plants in the field of Mr. E. P. Pearce, Hamlet, North Carolina, in the portion which had been

sprayed, whereas an average of one in every five berries was affected in the unsprayed portion. A detailed account of this work should be prepared for publication during the year.

In addition to the work on the regularly listed projects noted above, some work has been done with other diseases. Studies of cotton blight due to *Ascochyta Gossypii* have been continued. The disease is evidently carried on cotton seed. Typical lesions bearing fruit bodies of the fungus were present on cotyledons of seedling plants collected in several counties. Spore material was sufficiently abundant and well distributed to make possible a widespread epidemic of cotton blight if the weather conditions had been favorable. The dry weather of the past season effectively held the disease in check with the exception of two local outbreaks of an epidemic nature which followed several days of rainy weather and which terminated abruptly with the coming of drier weather.

A disease very similar to cotton blight in many respects was found on okra in Robeson County. The organism has been isolated from okra, but there has not yet been sufficient time to determine whether the organisms isolated from okra and cotton are identical.

B. W. WELLS, *Head, Department of Botany.*

F. A. WOLF and S. G. LEHMAN,

Collaborating in Research Work.

REPORT OF DIVISION OF HORTICULTURE

SWEET POTATO INVESTIGATIONS

The past season completes the seventh year of sweet potato variety tests in which the varieties were studied from the standpoint of production, market value, keeping quality, earliness and eating quality. The work on this project is being concluded and the data is being prepared for publication.

The work of the past year concludes a six-year study of slips versus vine cuttings for reproduction in potatoes. The results indicate that vine cuttings planted concurrently with slips will out-yield the slips.

A seven-year study of the effects of cutting vines on yield, indicates a loss in production proportionate to the amount of cutting. The results have been consistent throughout with the exception of the past season. The failure of vine cutting to reduce the yield was probably due to the heavy rains of late summer and early fall.

During the past two years spacing tests with sweet potatoes have resulted in the higher yields from the closer spacing.

Tests of high and low ridging for potatoes conducted during the past six years indicate increased yields from the higher ridging.

Observations on the storage of sweet potatoes show the advantage of crate storage over ordinary bin storage. A comparison of the keeping qualities in relation to the time harvested gave unexpected results. At the lower Coastal Plain Station potatoes harvested long after frost kept as well as those harvested before frost. At the Upper Coastal Plain Station the reverse was true.

Seed selection from high yielding hills was followed by higher yielding progeny than the average seed of the variety from which they came. The inheritance of type was rather disappointing. Continuous selection within the hill line did not improve the type or yield within the strain.

CABBAGE INVESTIGATIONS

In a study of seventeen cabbage varieties for the purpose of finding desirable late varieties, Copenhagen and Danish Ballhead have shown greatest promise.

IRISH POTATO INVESTIGATIONS

Storage of Early Crop Potatoes—This year's work confirms previous work to the effect that Irish potatoes of the early crop can be successfully stored in a sweet potato storage house until September or October. In September sprouting begins, which is later followed by shriveling.

Source of Seed Potatoes—The comparison of Maine versus Western North Carolina grown seed potatoes has been continued. Immature seed raised at the Mountain Station were inferior to mature seed, and the North Carolina mountain certified Cobbler seed were as good as Maine certified Cobbler seed in regard to yield and earliness. The plantings were made in the eastern part of the State.

Irish Potato Seed Treatment—A treatment for seed potatoes which would insure greater percentage of stand and earlier production would be valuable

to potato growers of the State. The practice among farmers of treating their seed sweet potatoes with a solution of nitrate of soda and the results of the California Experiment Station suggests tests of this matter under field and greenhouse conditions. Under greenhouse conditions the results compared favorably with those secured by California, but under field conditions the nitrate of soda treatment failed to stimulate early maturity or higher yield.

LETTUCE INVESTIGATIONS

Studies were conducted to determine the effects of fertilizers, varieties and shading upon the control of tip burn in lettuce. During the past season none of the above measures gave sufficient control to be of practical value.

Fruit Variety Adaptations—Observations on varieties of peaches, apples and pears were made at the branch station farms, and in commercial plantings of the State. The State and local fairs have also been a source of information for this project. Descriptions were made of the Golden Delicious apple and Augbert peach, and other descriptions have been checked as typical fruits were sent in.

ORIGIN OF NATIVE VARIETIES

Special attention was given to a study of the Cathelwood pecan originated at Durham, North Carolina, and new varieties originated at the Coastal Plain Branch Station.

NUTS OTHER THAN PECANS

Observations were made at Rocky Mount and Swannanoa of the behavior of black walnuts, Japan walnuts, and northern varieties of pecans. With the exception of black walnuts, the above nuts have not been adapted to our conditions.

APPLE VARIETIES FOR EASTERN NORTH CAROLINA

Further comparisons of apple varieties at the Coastal Plain Station confirm previous observations that blight is the principal limiting factor in the successful production of apples in eastern North Carolina. The Eckles Sweet Red June has proved most resistant to blight.

APPLE PRUNING

In a comparison of light and heavy pruning of apple trees, light pruning has given larger tree growth, earlier production and greater production.

PEACH VARIETIES COMPARED FOR HARDINESS

Yield and phenological data was secured from several varieties planted in western North Carolina in 1919. Among the varieties most outstanding for hardiness are Crosby, Engle and Kalamazoo.

PECAN VARIETIES

Yield, growth and quality data was secured from thirty varieties grown at the Coastal Plain Stations. Observations were also made at Statesville and Swannanoa. The results indicate the superiority of Schley, Stuart, Alley and Success, from the standpoint of yield.

Top-Working Pecans—Further records were taken on the yields and growth of trees that were top-worked in 1913. The results indicate that top-working is practical with trees eight years and under. The combination of slip bark grafting and patch budding has given the best results.

Pecan Cracking Tests—In the cracking tests of pecans to determine the quality of different varieties, Schley, Alley, Success, Curtis and Stuart have given the best results.

A STUDY OF THE TRANSMISSION OF CHARACTERS IN THE HYBRIDS OF *VITIS ROTUNDIFOLIA*

The Inheritance of Quality

To study the factors controlling the various qualities of *Vitis rotundifolia*, such as the clinging character of the berries, the thickness of skin, transpiration, flavor, aroma, and disease resistance, with a view to finding methods of improvement.

Data collected to date show the following tendencies and results:

Cling quality of the berry apparently does not exist within this species, and such clinging as does exist is only relative and not inherent as a unit character, but is probably a problem of abscission.

Size of clusters, size of berry, and thickness of skin are inherited, but are not unit characters, and are as much or more influenced by environment.

Irregularities in the data collected may possibly be explained by unsatisfactory cultural conditions. A race of self-fertile vines shows a marked increase in the size of flower clusters (double or treble), but the average size of fruit cluster is about the same, and in many cases lower than in the self-sterile vines. Not only are many of the pistils abortive, but also much of the pollen is impotent. Many of these self-fertile vines would probably be more productive under better cultural conditions. Transpiration of the fruit is greater than in the case of bunch grapes, probably due to the presence of lenticels in the skin of the berry, and is fairly uniform for all varieties, and has not been correlated with thickness of skin.

Efforts in breeding during the past year were concentrated on making crosses between the most promising seedlings with the purpose of producing self-fertile vines bearing high quality fruit of large berries, in large clusters of the three colors—red, black and white. The work was outlined with reference to collected data which has made it possible to select parents to a higher degree than hitherto.

This year thirteen crosses were made resulting in four hundred and fifty-six seed. Work is also under way to propagate the best seedlings resulting from crosses previously made. Some of these show a great deal of promise.

Hybridization with Other Species

To determine the various species with which *Vitis rotundifolia* will hybridize, to find methods of overcoming antipathy where it occurs, and to establish a scale of hybridization of *Vitis rotundifolia* with other species.

Attempts have been made to hybridize *Vitis rotundifolia* with thirteen other species of *Vitis*, three species of *ampelopsis*, and eleven varieties of *Euvitis* hybrids (bunch grapes). Seven direct crosses with *Vitis* were

obtained, and four reciprocal, none with Ampelopsis, and five direct and no reciprocal with the bunch grapes. This species will hybridize freely with Vinifera and such northern species as Labrusca, and less easily with such southwestern species as Arizonica and Californica. Failure of the reciprocal crosses apparently is due to the slower growth of bunch grape pollen on rotundifolia pistils possibly owing to an inhibiting factor. Hybrid offspring continue to show marked sterility, low vigor, and more susceptibility to disease. Numerous attempts have been made to get an F2 generation, using twenty different combinations, but securing only three seedlings.

Breeding Raspberries

To secure varieties of raspberries suitable for the South, by discovery or breeding, and to formulate a method of procedure in breeding bramble fruits.

This was the second year of breeding in this project. Thirteen crosses were made, using eight varieties of Rubus species, but yielding only fifty-six seed. Observations are being continued to find which plants are best suited for the climatic conditions and which make the best parents. To date Rubus phoenicolasius shows the best vigor, and varieties Haymaker and Winfield the easiest parents to use. Crosses have been secured with the Himalaya berry, Rubus thyrsanthus, and it is hoped that this will make a promising combination.

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